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(54) **ELECTRO-OPTICAL SCANNER HAVING EXIT WINDOW WITH LIGHT COLLECTING OPTICS**

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G02B 26/00 (2006.01)

(52) **U.S. Cl.** **235/462.35**; 235/454; 235/462.43; 359/362; 359/363; 359/364

(58) **Field of Classification Search** 235/462.45, 235/462.22, 462.32, 462.23, 462.35, 462.43, 235/454; 359/362–364
See application file for complete search history.

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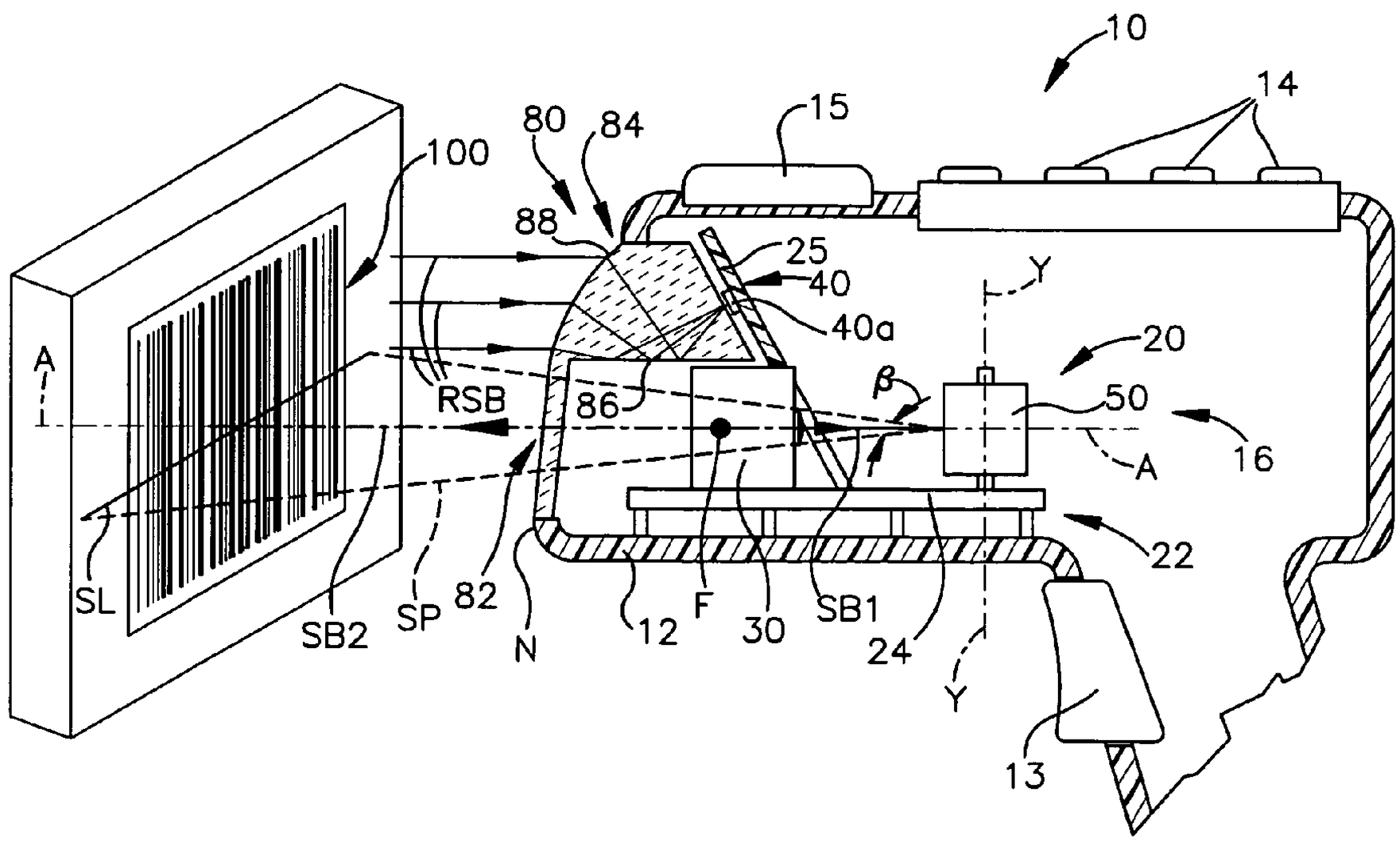
(57) **ABSTRACT**

A portable electro-optical scanner for reading a target bar code having a plurality of bar code elements. The portable scanner includes: a housing supporting a scanning module and an optic system. The scanning module electro-optically scans the target bar code with a scanning beam and collects reflected light returning from the bar code. The scanning module includes a beam source emitting a scanning beam, beam directing apparatus causing the scanning beam to be repetitively scanned along a scanning plane intersecting the target bar code and photodetector circuitry receiving light from the target bar code. The optic system includes an exit window, a light collection lens and a reflective surface. The scanning beam passes through the exit window upon exiting the housing. The light collection lens receives reflected light from the target bar code and directing the reflected light toward a focal point. The focal point lying on the scanning plane of the scanning beam. The reflective surface is disposed between the light collection lens and the focal point to redirect the reflected light passing through the light collection lens toward the photodetector circuitry.

23 Claims, 2 Drawing Sheets



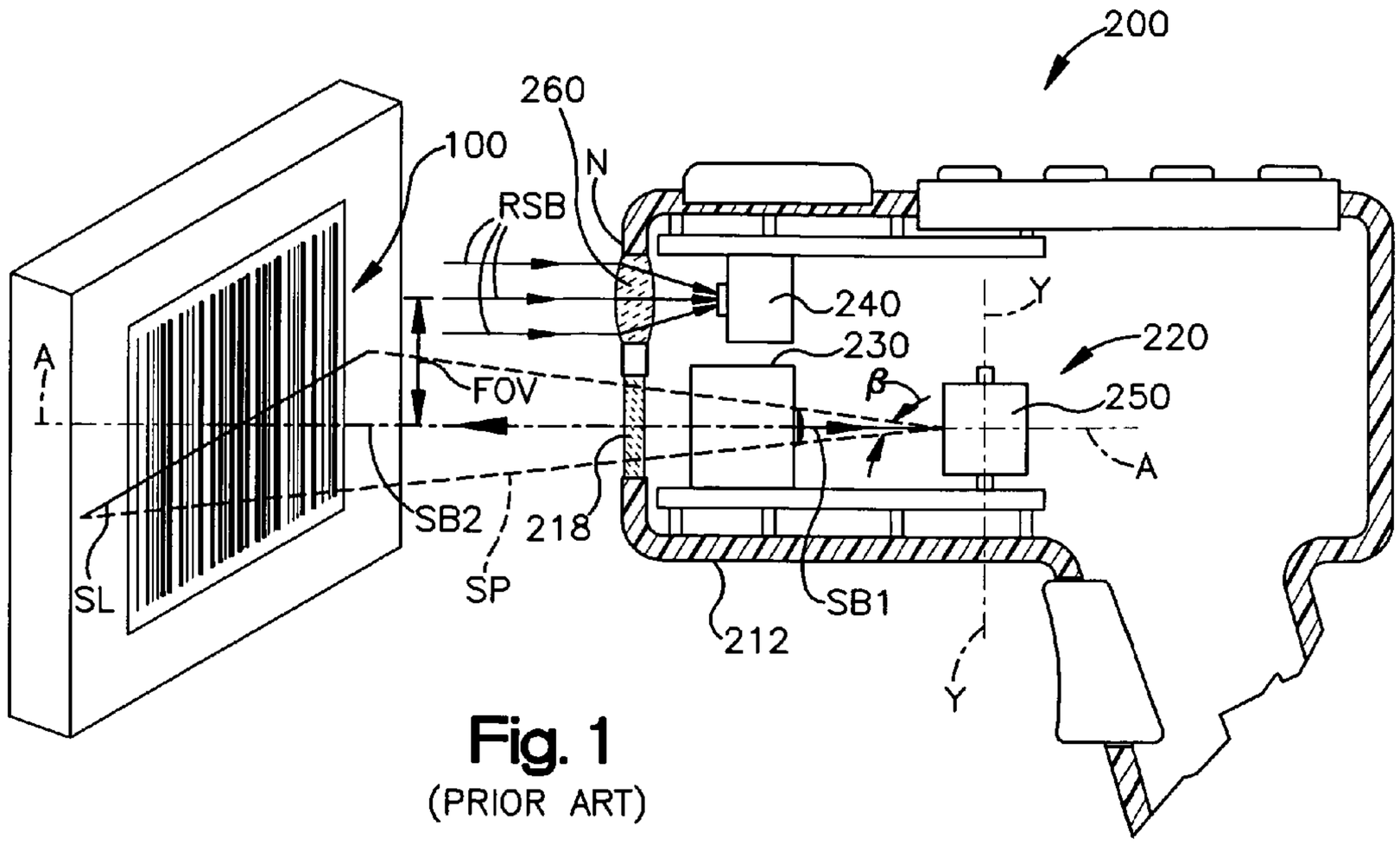


Fig. 1
(PRIOR ART)

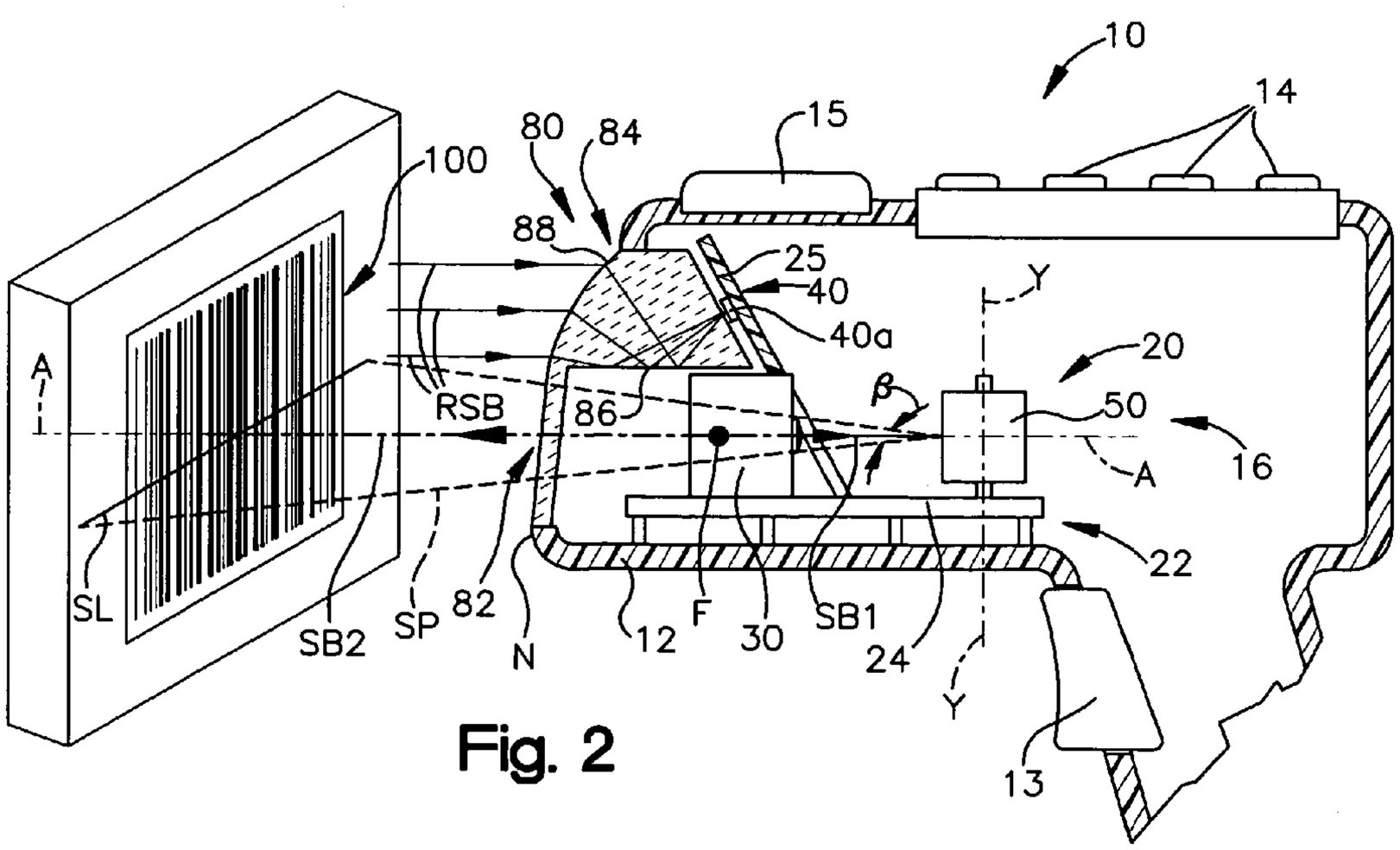


Fig. 2

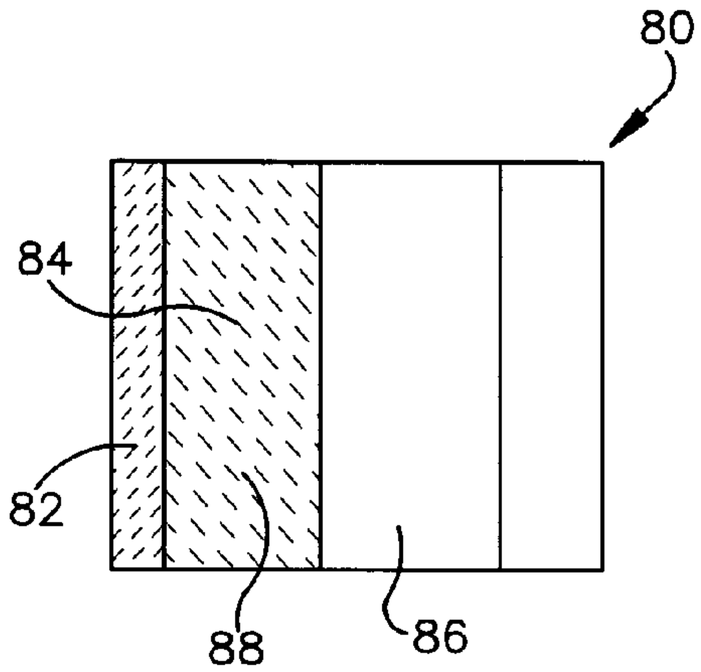


Fig. 4

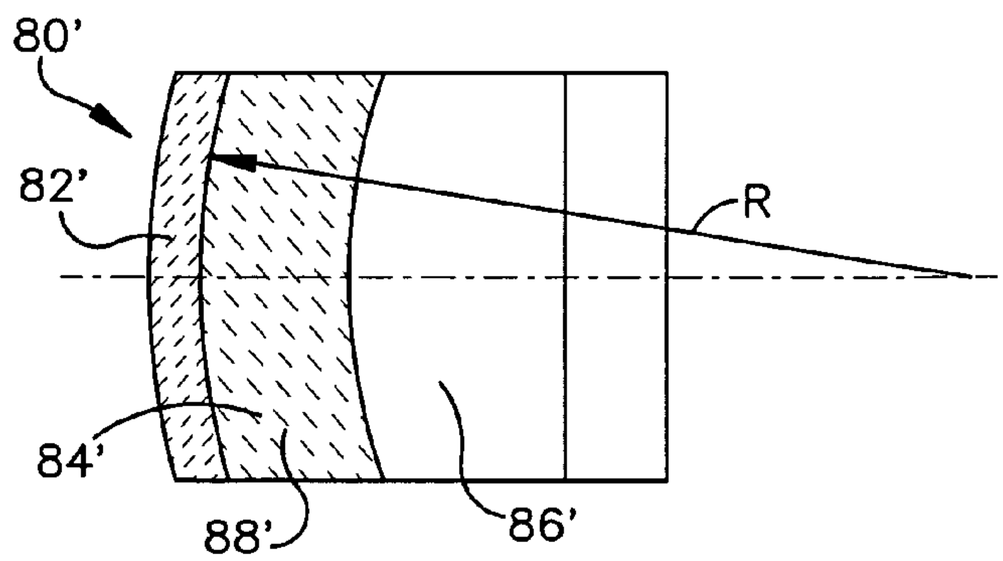


Fig. 5

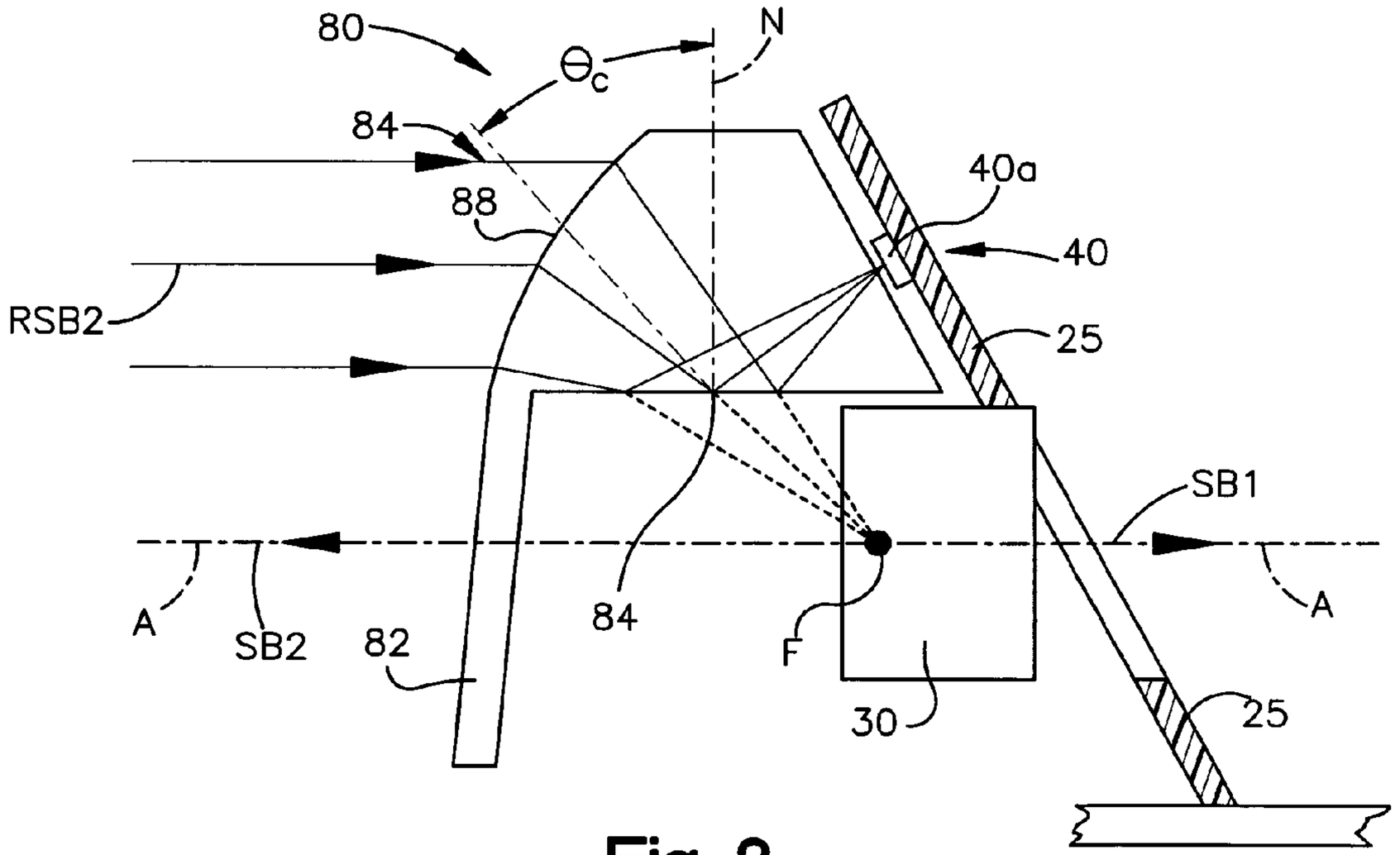


Fig. 3

ELECTRO-OPTICAL SCANNER HAVING EXIT WINDOW WITH LIGHT COLLECTING OPTICS

FIELD OF THE INVENTION

The present invention relates to an electro-optical scanner for reading bar codes and, more particularly, to a non retro-reflective scanner including an exit window having a light collecting system incorporating a total internal reflection surface.

BACKGROUND OF THE INVENTION

Electro-optical scanners are widely used for reading bar codes, including one dimensional and two dimensional bar codes. A scanner typically includes a scanning module which: generates a scanning beam; repetitively directs and scans the beam across a target object, such as a bar code; receives reflected light from the target object; and digitizes and decodes the reflected light to decode the information encoded in the bar code. The scanning module is supported in a housing of the hand held portable scanner which also supports a power supply and other electronics of the scanner.

The scanning module scanning beam (typically a laser beam emitted by a laser diode) is directed at an oscillating scanning mirror. The oscillating scanning mirror, in turn, directs the beam outwardly through an exit window of the scanner. The exit window of the scanner functions to protect the internal components of the scanner supported within the scanner housing from the outside environment. The oscillation of the oscillating reflector causes the scanning beam to oscillate across a target object such as a bar code to be read. Essentially, the beam generates a beam spot that repetitively moves across or scans the bar code.

The light-colored or space elements of the bar code reflect the laser beam illumination and the dark or black bar elements of the bar code absorb the laser beam. Reflected light from the target bar code is received by a reflective surface such as a collection mirror and/or a lens and directed toward photodetector circuitry, such as a photodiode. The pattern of reflected light, as received by the photodiode of the scanning module, is a representation of the pattern of the bar code. That is, a sequence of time when the photodiode is receiving reflected light represents the laser beam spot moving across a space of the bar code, while a sequence of time when the photodiode is not receiving reflected light represents the laser moving across a dark bar. Since the scanning speed or velocity of the reciprocating movement of the laser is known, the elapsed time of the photodiode receiving reflected light can be converted into a width of a bar code element corresponding to a space, while the elapsed time of the photodiode not receiving reflected light can be converted into a width of a bar code element corresponding to a bar.

The photodiode is part of photodetector circuitry which converts the reflected light into an analog signal. The scanning module includes an A/D converter or digitizer to digitize the analog signal generated by the photodiode. The digitizer outputs a digital bar code pattern (DPB) signal representative of the bar code pattern. A decoder of the scanning module inputs the DPB signal and decodes the bar code. The decoded bar code typically includes payload information about the product that the bar code is affixed to. Upon successful decoding of the scanned bar code, the scanner may provide an audio and/or visual signal to an operator of the scanner to indicate a successful read and

decode of the bar code. The scanner typically includes a display to display payload information to the operator and a memory to store information decoded from the bar code.

One type of electro-optical scanner, referred to as a retro-reflective scanner, employs retro-reflective light collection. In a retro-reflective scanner, the scanning module includes a mirror that both: 1) directs the scanning beam toward the target bar code or another mirror; and 2) receives reflected light from target bar code and directs it toward the photosensor circuitry. Another type of electro-optical scanner is referred to as a non retro-reflective scanner. In such a non retro-reflective scanner, the mirror that receives the reflected illumination and directs it toward the photodetector circuitry is physically separate from the mirror that directs the laser beam toward the target bar code.

A prior art portable electro-optical non retro-reflective scanner is shown at **200** in FIG. **1**. The scanner **200** includes a housing **212** supporting a scanning module **220** which includes a laser diode light assembly **230** for emitting a scanning beam. The scanning beam (labeled SB**1**) is directed to a mirror **250** which repetitively oscillates about a vertical axis Y-Y through a scanning angle β. The redirected scanning beam (labeled SB**2**) exits the housing **212** through an exit window **218**. Because of the oscillation of the mirror **250**, the scanning beam SB**2** is repetitively scanned in a horizontal direction forming a linear scan line SL.

Since the beam line SB**2** is being scanned horizontally, the beam forms a horizontal scan line SL (FIG. **1**) which extends across the bar code **100**. Thus, a pie shaped scanning plane SP is formed emanating from the oscillating mirror **250**. To scan and read a target bar code **100**, the scan line SL is positioned to intersect the target bar code as shown in FIG. **1**. Illumination or light from the scan line SL reflected from the target bar code **100** (labeled RSB in FIG. **1**) passes through a light collection lens **260** and is focused on photodetector circuitry **240**.

In non retro-reflective scanners, the light collection lens **260** (or system of lens) is typically employed to collect light reflected from the target bar code **100** and focus the reflected light rays RSB on the photodetector circuitry **240**. As can be seen in FIG. **1**, the light collection lens **260** is spaced from the scanning beam SB**2**, that is, the scanning beam SB**2** does not pass through the light collection lens. One problem with the collection lens **260** of a non retro-reflective scanner stems from parallax effect. Because the collection lens **260** is spaced from the beam line SB**2**, an optical axis of the lens does not lie on the same axis as the scanning beam SB**2** and, therefore, there is a parallax effect. An optical axis of a lens is defined as the straight line which passes through the center of curvature of the lens surface. A central ray though the scan plane SP is defined as the scanning beam line axis A-A.

For example, as is shown in FIG. **1**, if the light collection lens **260** is disposed vertically above the scanning beam line axis A-A, because of the parallax effect, the light collection lens must be provided with an additional field of view (labeled FOV in FIG. **1**) in a direction orthogonal to the beam axis A-A (that is, in the vertical direction) to be able to "see," that is, receive and focus reflected light from the scan line SL as it traverses or intersects the bar code **100**. This is because the scan line SL intersects the bar code **100** at a vertical level that is below the level of the lens **260**. Thus, the light collection lens **260** must look downwardly to "see" reflected light from the scan line SL impinging upon the target bar code **100**. Stated another way, the light collection lens **260** must have a vertical field of view to "see" reflected light from the scan SL when scanning bar codes which are close in proximity to a forward nose N of

the scanner and bar codes which are more distant. Unfortunately, an unfortunate result of increasing the vertical field of vision of the light collection lens **260** more ambient light (that is, light not reflected from the scan line SL) is focused on the photodetector circuitry decreasing the signal-to-noise ratio and generally making it more difficult to successfully decode the target bar code **100**.

What is desired is a light collection lens system that would substantially eliminate the parallax effect in non retro-reflective scanners. What is also needed is a light collection lens system that would eliminate or reduce the need for additional FOV in a direction orthogonal to the scanning beam axis. What is also needed is a light collection lens system that reduces the amount of ambient light focused on the photodetector circuitry.

SUMMARY OF THE INVENTION

The present invention is directed to a portable electro-optical scanner for reading a target bar code having a plurality of bar code elements. The portable scanner includes a housing supporting a scanning module for electro-optically reading the target bar code by the bar code with a scanning beam and collecting reflected light returning from the bar code, the scanning beam and the reflected light passing through an optic system supported by the housing. The scanning module includes a beam source, beam directing apparatus and photodetector circuitry. The beam source emits a scanning beam which is repetitively scanned across the target bar code by beam directing apparatus. Repetitive scanning of the scanning beam defines a pie-shaped scanning plane originating from the beam directing apparatus.

The optics system includes an integral exit window, light collection lens and a reflective surface. The scanning beam exits the housing through the exit window and reflected light from the target bar code is received by the light collection lens. The light collection lens is configured to direct the reflected light to a focal point which is located in the scanning plane of the scanning beam. Stated another way, the optical axis of the light collection optics coincides with the scanning plane. The reflective surface is disposed between the collection lens and the collection lens focal point to direct the reflected light focused by the collection lens toward the photodetector circuitry.

Having the focal point of the light collection lens lie in the plane of the scanning beam substantially eliminates the parallax effect. Thus, the light collection lens does not require an additional field of view in a direction orthogonal to the scanning beam axis. Moreover, since the light collection lens does not require an additional field of view in a direction orthogonal to the scanning beam axis, the amount of ambient light impinging on the photodetector circuitry is reduced, thereby improving the signal to noise ratio and the quality of the signal output by the photodetector circuitry.

In one aspect, the present invention features a portable electro-optical scanner for reading a target bar code having a plurality of bar code elements. The portable scanner includes:

a) a housing supporting a scanning module and an optic system;

b) the scanning module electro-optically reading the target bar code with a scanning beam and collecting reflected light returning from the bar code, the scanning module including a beam source emitting a scanning beam, beam directing apparatus causing the scanning beam to be repetitively scanned along a scanning plane across the target bar code and photodetector circuitry receiving light from the target bar code; and

c) the optic system including:

1) an exit window through which the scanning beam passes upon exiting the housing;

2) a light collection lens receiving reflected light from the target bar code and directing the reflected light toward a focal point located on the scanning plane of the scanning beam, and

3) a reflective surface disposed between the light collection lens and the collection lens focal point to redirect the reflected light passing through the light collection lens toward the photodetector circuitry.

These and other objects, advantages, and features of the exemplary embodiment of the invention are described in detail in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is schematic view, partly in section and partly in front elevation, of a prior art electro-optical non retro-reflective scanner;

FIG. **2** is a schematic view, partly in section and partly in front elevation, of a portion of an electro-optical non retro-reflective scanner including an exit window of the present invention having an integral light collection system;

FIG. **3** a schematic side elevation view of the exit window of FIG. **2**;

FIG. **4** is a schematic top plan view of the exit window of FIG. **2**; and

FIG. **5** is a schematic top plan view of a second embodiment of an exit window of the present invention.

DETAILED DESCRIPTION

A portable electro-optical scanner of the present invention is shown schematically at **10** in FIG. **2**. The scanner **10** may be used to scan and decode bar codes, such as, **1**D and **2**D bar codes and postal codes. As used herein, the term "bar code" is intended to be broadly construed to cover not only bar code symbol patterns comprised of alternating bars and spaces, but also other graphic patterns, such as dot or matrix array patterns and, more generally, indicia having portions of different light reflectivity or surface characteristics that result in contrasting detected signal characteristics that can be used for encoding information and can be scanned and decoded with the scanner **10**. FIGS. **1** and **2** depict a target **1**D bar code **100** affixed to a product **102**.

In one preferred embodiment of the present invention, the scanner **10** is a hand held, portable bar code reader. The scanner **10** is supported in a housing **12** that can be carried and used by a user walking or riding through a store, warehouse or plant for reading bar codes for stocking and inventory control purposes.

However, it should be recognized that scanner **10** of the present invention may be embodied in a stationary scanner. It is the intent of the present invention to encompass all such scanners.

The scanner **10** includes an actuation trigger **13**, a set of user input keys **14** and a visual display **15** for displaying decoded and/or other information. A speaker (not shown) providing an audio output to a user of the scanner **10** upon successful scanning and decoding of the target bar code **100** may also be provided. Also provided are data communications ports (not shown) and/or an rf transceiver (not shown) for uploading and downloading information to a remote

computer system. The actuation trigger **13**, input keys **14**, display **15** and other input/output components are coupled to the circuitry **16** supported in the housing **12**.

The scanner circuitry **16**, which operates under the control of one or more microprocessors, includes a non retro-reflective scanning module **20**. The scanning module **20** is supported by a housing **22** which includes a printed circuit board base **24** and an angled extending circuit board **25** which extends upwardly at an angle from the base **24**. The scanning module **20** includes a laser diode assembly **30** for producing a scanning beam SB**1**, photodetector circuitry **40** including a photodiode **40***a* for receiving light reflected from the target bar code **100** and converting the light to an analog signal representative of the pattern of dark bars and light spaces of the bar code **100**. The analog signal output by the photodetector circuitry **40** is digitized and decoded by an A/D converter and decoding circuitry, which are part of the scanner circuitry **16**.

The scanning module **20** also includes a mirror **50** which is oscillated by a drive mechanism about an axis Y-Y (FIG. **2**) through an arc or scanning rotation angle β. The mirror **50** intersects the scanning beam line SB**1** generated by the laser diode assembly **30**.

The laser diode assembly **30** and mirror **50** are affixed to the printed circuit board **24**. The diode assembly **30** includes a laser diode and focusing optics which generate a scanning beam SB**1** that is directed at the beam reflecting mirror **50**, the beam line SB**1** is reflected, redirected and scanned in a horizontal direction by the oscillating mirror **50**. The redirected beam line SB**2** exits and intersects the target bar code **100**. Since the beam line SB**2** is being scanned horizontally, the beam forms a horizontal scan line SL (FIG. **2**) which extends across the bar code **100**. Thus, as is shown schematically in dashed line in FIG. **2**, a pie shaped scanning plane SP is formed emanating from the oscillating mirror **50**. A central ray of the scanning plane SP defines a scanning beam line axis labeled as A-A in FIG. **2**. Light from the scan line SL reflects off of the target bar code **100** and is received by the photodiode **40***a* of the photodetector circuitry **40** and decoded by decoding circuitry.

Optic Assembly **80**

The scanner **10** utilizes a novel optic assembly or system **80** that includes an integral exit window **82** and a light collection lens **84**. A lower planar surface of the light collection lens **84** includes a light reflective surface **86**. Advantageously, the exit window **82** and light collection lens **84** may be molded out of plastic into a single, integrated optical element. The optical element **80** may be fabricated of acrylic, polycarbonate, or ZEONEX® polymer resin made by Zeon Chemicals L.P., Louisville, Ky. 40211. Other moldable plastics may be used, as would be recognized by one of skill in the art. Alternately, the exit window **82** and light collection lens may be separate components. It is the intent of the present invention to cover both such embodiments.

The scanning beam SB**2** exits the housing through the exit window **82**. The exit window **82** may be flat with respect to the scanning beam line axis A-A. Alternately, as shown in FIG. **2**, the exit window **82** may be slightly canted or angled upwardly with respect to the scanning beam line axis A-A to minimize internal light scattering from the laser diode **30**. The exit window is a flat optic piece with an optic power of zero. However, if it is desired for beam shaping purposes, the exit window **82** may be configured to have a non-zero optic power in either the horizontal direction (that is, the direction along the scan line SL) or the vertical direction (orthogonal to the scan line SL).

Reflected light from the target bar code **100** is shown as a set of parallel rays RSB in FIG. **2**. At typical scanning distances (the distance from the nose N of the scanner **10** to the bar code **100**), the reflected light rays RSB may be assumed to be parallel. The light collection lens **84** is configured such the reflected light rays RSB are directed to a focal point F along an optical axis of the lens **84** that intersects the scanning beam axis A-A. Stated another way, a convex surface **88** of the lens **84** converges/collects the reflected light rays RSB at the focal point F which lies on the scanning plane SP. When the focal point F is said to lie on the scanning plane SP what is meant is that the focal point of the lens **84** is located on or very near the scanning plane SP such that the parallax effect is minimized or substantially reduced.

Unfortunately, the photodiode **40***a* physically cannot be located at the focal point F because the laser diode assembly **30** is physically located at or near F. Therefore, the light reflective surface **86** is disposed between the collection lens **84** and the focal point F of the lens. Reflected light rays that are incident on the surface **86** at shallow angles, that is, angles that are greater than the critical angle (θ_C) when measured with respect to a normal to the surface **86**, then total internal reflection (TIR) of those reflected light rays occurs (rather than refraction) and the reflected light rays are directed by the reflected surface **86** toward the photodiode **40***a* located on the PC board **25**.

The critical angle (θ_C) is defined as:

$$\theta_C=\sin^{-1}(n2/n1)$$

where, θ_C is the angle from a line normal to the boundary of the first and second media and n**1** and n**2** are the indices of refraction of the first and second media, respectively. For n**2**<n**1**, a ray incident at an angle greater than θ_C will undergo total internal reflection (TIR). Here, at the boundary, that is, at the reflective surface **86**, n**1** is the index of refraction of the lens **84**, while n**2** is the index of refraction of air. Just by way of example, assume that the index of refraction of the lens **84** is n**1**=1.5 and the index of refraction of air is n**2**=1.0, then

$$\theta_C=\sin^{-1}(n2/n1)$$

$$\theta_C=\sin^{-1}(1.0/1.5)$$

$$\theta_C=\sin^{-1}(0.667)$$

$$\theta_C=\sin^{-1}(0.667)$$

$$\theta_C=41.8°$$

Since the critical angle θ_C (about 42°) is measured with respect to a line normal to the boundary, that is, normal to the reflective surface **86**, any ray of reflected light that is incident on the surface at an angle greater than 42° from the normal will have TIR of the ray. Stated another way, any reflected light ray that is incident on the surface **86** at an angle shallower than 48° measured from a horizontal axis coincident with the reflective surface **86** will have TIR. For example, in FIG. **3**, the reflected light ray RSB**2** has the critical angle θ_C drawn in dashed line from the normal line N. Since the ray RSB**2** has an angle of incidence greater than critical angle when measured from the normal line N, there is TIR of the ray RSB**2**.

Additionally, the light reflective surface **86** may be coated with a highly light reflective coating such as silver to reflect

those reflected light rays that are incident on the surface **86** at angles greater than the critical angle. However, it should be recognized that by proper choice of the configuration of the light collection lens **84** TIR at the reflective surface **86** may be achieved without the necessity of coating, that is, if all rays are incident on the surface **86** at an angle greater than the critical angle.

As can best be seen in FIG. **3**, the light reflective surface **86** provides total internal reflection (TIR) of the reflected light rays RSB and redirect the rays through the lens **84** toward the photodiode **40***a* located on the PC board **25**.

FIG. **4** provides a schematic top view of the optic assembly **80**. As can be seen the light collection lens **84** is cylindrical. The cylindrical surface looks straight when viewed from the top. However, other shapes for the light collection lens may be used. For example, in FIG. **5**, the optic assembly **80'** includes a exit window **82'** and a light collection lens **84'** which are toroidal. A toroidal surface has a radius of curvature R when viewed from the top. The optic assembly **80'** includes a reflective surface **84'** like the reflective surface **84** for TIR to redirect the reflected light rays RSB to the photodiode **40***a*. Alternately, the convex surface **88** of the light collection lens **84** may also be a Fresnel lens.

While the present invention has been described with a degree of particularity, it is the intent that the invention includes all modifications and alterations from the disclosed design falling with the spirit or scope of the appended claims.

We claim:

1. A portable electro-optical scanner for reading a target bar code having a plurality of bar code elements, the portable scanner comprising:

a housing supporting a scanning module and an optic system;

the scanning module electro-optically scanning the target bar code with a scanning beam and collecting reflected light returning from the bar code, the scanning module including a beam source emitting a scanning beam, a beam directing apparatus causing the scanning beam to be repetitively scanned along a scanning plane intersecting the target bar code and a photodetector circuitry receiving light from the target bar code; and

the optic system including:

an exit window through which the scanning beam passes upon exiting the housing;

a light collection lens receiving reflected light from the target bar code and directing the reflected light toward a focal point of the lens, the focal point located on the scanning plane between the exit window and the beam directing apparatus, and

a reflective surface disposed between the light collection lens and the collection lens focal point to redirect the reflected light passing through the light collection lens toward the photodetector circuitry.

2. The portable electro-optical scanner of claim **1** wherein the exit window and the light collection lens are integral.

3. The portable electro-optical scanner of claim **1** wherein the exit window and the light collection lens are fabricated of a single molded component.

4. The portable electro-optical scanner of claim **1** wherein the reflective surface redirects the reflected light by total internal reflection of rays of reflected light that are incident on the reflective surface at angles greater than a critical angle measured with respect to a line normal to the reflective surface.

5. The portable electro-optical scanner of claim **1** wherein the reflective surface includes a reflective coating applied to the reflective surface.

6. The portable electro-optical scanner of claim **1** wherein the beam directing apparatus is a rotating mirror.

7. An optic assembly for a portable electro-optical scanner adapted to read a target bar code having a plurality of bar code elements wherein the portable scanner includes a housing supporting a scanning module and the optic assembly, the scanning module scanning the target bar code with a scanning beam and collecting reflected light returning from the bar code and including a beam source emitting a scanning beam, a beam directing apparatus causing the scanning beam to be repetitively scanned along a scanning plane intersecting the target bar code and a photodetector circuitry receiving light from the target bar code, the optic assembly comprising:

an exit window through which the scanning beam passes upon exiting the housing;

a light collection lens receiving reflected light from the target bar code and directing the reflected light toward a focal point of the lens, the focal point of the lens lying on the scanning plane between the exit window and the beam directing apparatus; and

a reflective surface disposed between the light collection lens and the collection lens focal point to redirect the reflected light passing through the light collection lens toward the photodetector circuitry.

8. The optic assembly of claim **7** wherein the exit window and the light collection lens are integral.

9. The optic assembly of claim **7** wherein the exit window and the light collection lens are fabricated of a single molded component.

10. The optic assembly of claim **7** wherein the reflective surface redirects the reflected light by total internal reflection of rays of reflected light that are incident on the reflective surface at angles greater than a critical angle measured with respect to a line normal to the reflective surface.

11. The optic assembly of claim **7** wherein the reflective surface includes a reflective coating applied to the reflective surface.

12. A scanning module for a portable electro-optical scanner adapted to read a target bar code having a plurality of bar code elements by scanning the target bar code with a scanning beam and collecting reflected light returning from the bar code, the scanning module comprising:

a beam source emitting a scanning beam;

a beam directing apparatus causing the scanning beam to be repetitively scanned along a scanning plane intersecting the target bar code;

a photodetector circuitry receiving light from the target bar code; and

an optic system including:

an exit window through which the scanning beam passes when moving toward the target bar code;

a light collection lens receiving reflected light from the target bar code and directing the reflected light toward a focal point intersecting the scanning plane of the scanning beam between the exit window and the beam directing apparatus, and

a reflective surface disposed between the light collection lens and the collection lens focal point to redirect the reflected light passing through the light collection lens toward the photodetector circuitry.

13. The scanning module of claim **12** wherein the exit window and the light collection lens are integral.

14. The scanning module of claim 12 wherein the exit window and the light collection lens are fabricated of a single molded component.

15. The scanning module of claim 12 wherein the reflective surface redirects the reflected light by total internal reflection of rays of reflected light that are incident on the reflective surface at angles greater than a critical angle measured with respect to a line normal to the reflective surface.

16. The scanning module of claim 12 where the reflective surface includes a reflective coating applied to the reflective surface.

17. A portable electro-optical scanner for reading a target bar code having a plurality of bar code elements, the portable scanner comprising:

a housing supporting a scanning module and an optic system;

the scanning module electro-optically scanning the target bar code with a scanning beam and collecting reflected light returning from the bar code, the scanning module including a beam source emitting a scanning beam, a beam directing apparatus causing the scanning beam to be repetitively scanned along a scanning plane across the target bar code and a photodetector circuitry receiving light from the target bar code; and

the optic system including:

an exit window through which the scanning beam passes upon exiting the housing;

a light collection lens receiving reflected light from the target bar code and directing the reflected light toward a focal point where an optical axis of the lens intersects the scanning plane of the scanning beam between the exit window and the beam directing apparatus, and

a reflective surface disposed between the light collection lens and the collection lens focal point to redirect the reflected light passing through the light collection lens toward the photodetector circuitry.

18. The portable electro-optical scanner of claim 17 wherein the exit window and the light collection lens are integral.

19. The portable electro-optical scanner of claim 17 wherein the exit window and the light collection lens are fabricated of a single molded component.

20. The portable electro-optical scanner of claim 17 wherein the reflective surface redirects the reflected light by total internal reflection of rays of reflected light that are incident on the reflective surface at angles greater than a critical angle measured with respect to a line normal to the reflective surface.

21. The portable electro-optical scanner of claim 17 wherein the reflective surface includes a reflective coating applied to the reflective surface.

22. The portable electro-optical scanner of claim 17 wherein the beam directing apparatus is a rotating mirror.

23. An optic assembly for a portable electro-optical scanner adapted to read a target bar code having a plurality of bar code elements wherein the portable scanner includes a housing supporting a scanning module and the optic assembly, the scanning module scanning the target bar code with a scanning beam and collecting reflected light returning from the bar code and including a beam source emitting a scanning beam, a beam directing apparatus causing the scanning beam to be repetitively scanned along a scanning plane across the target bar code and a photodetector circuitry receiving light from the target bar code, the optic assembly comprising:

an exit window through which the scanning beam passes upon exiting the housing;

a light collection lens receiving reflected light from the target bar code and directing the reflected light toward a focal point where an optical axis of the lens intersects the scanning plane between the exit window and the beam directing apparatus; and

a reflective surface disposed between the light collection lens and the focal point to redirect the reflected light passing through the light collection lens toward the photodetector circuitry.

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